Space Weather Technical Forecast

Issued on Monday, 18 July 2022 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1-R2 Likely and Active electron fluence Expected initially. Chance G1 from CME arrival 19 into 20 July.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity reverted to Low over the UTC day of Sunday 17 July, with X-ray activity as measured at GOES16 almost entirely within C-class. Observed flares peaked with a C6.5 at 17/1227UTC from sunspot region AR3058 in the northeast quadrant. AR3058 was one of seven sunspots on the disc, with a Mt Wilson delta visible in its central region, in an overall classification of Dai/Beta-Delta. Other sunspot groups of note in terms of displaying a growing trend were AR3056, which showed some development and proliferation of its leading cluster in an otherwise diffuse Eai/Beta; and also trailer development in AR3057, which finished the 24 hours as an Ehi/Beta. Other sunspot groups were less dynamic, although a minor Cro/Beta was numbered in the period in the northwest quadrant as AR3061 as AR3053 became indistinct nearer the limb.

The main event visible in coronagraph imagery in the period was a fast westward-directed Coronal Mass Ejection (CME) emitted from near AR3053 around 17/0200UTC. This has been modelled and is off-ecliptic as well as being a long way west, meaning no effect is expected at Earth. No new Earth-directed CMEs were in evidence.

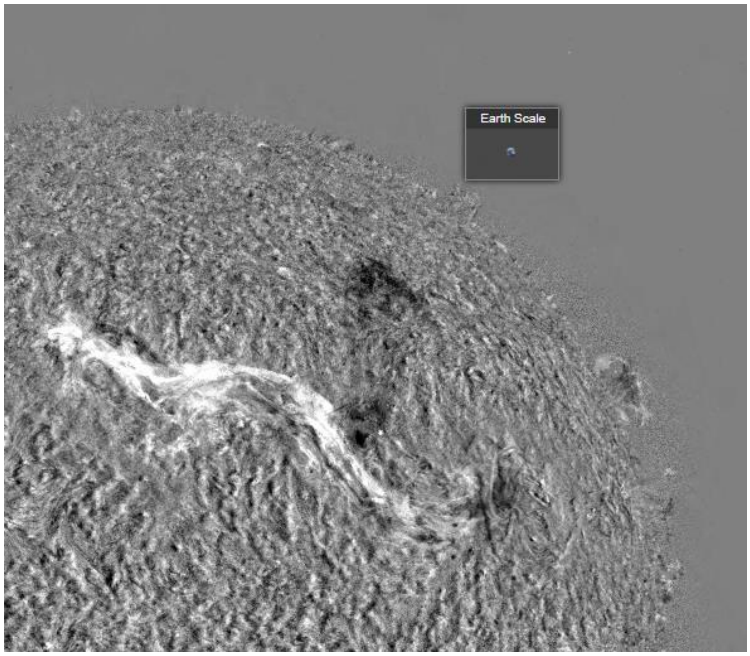

Figure 0: Helioviewer.org-generated 2-hour running difference plot in AIA304 imagery starting 15/1400UTC, showing the footprint of the large filament eruption in white and its trajectory during its departure from the sun in black. Also shown is the Earth for scale.

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Solar Wind / Geomagnetic Activity: The solar wind, as observed by ACE at L1, has been slightly elevated over the past 24 hours, likely from a waning high speed stream, possibly from CH99/+.

The solar wind speed was mostly slightly elevated, with a range of between 400 and 450km/s, with a slight downward tendency. The solar wind density was at normal background levels, well within single figures ppcc, but with a slight rising tendency later in the period. The IMF, meanwhile, showed a smooth slight decline from 7 to 5nT, while the north-south component varied between +/-4nT. The phi angle was positive (away from the Sun).

The net effect of the above solar wind measures was for Quiet geomagnetic activity, with a provisional peak of 2o in the 18-21UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at Background levels.

The high energy electron flux (greater than 2 MeV) has been High throughout, with a peak of 5270pfu at 17/1830UTC. The 24-hour integrated electron fluence remained above the Active (1e8 integrated pfu) threshold, with a rising trend and an observed value at 18/0001UTC of 2.61e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate, with a daily Slight Chance of X-class flares. Two of the current large sunspots should leave the Earth-facing side into the new UTC week, resulting in a slight reduction in flare probability. Arriving bright flux over the southeastern limb may compensate for any loss, however.

Solar Wind / Geomagnetic Activity: There is one confirmed CME in the forecast period: the 15/1300UTC filament CME, which is due around the turn of the UTC day 19 into 20 July.

The persistence forecast is expected to be less impactful, with CH03/- due on 19 July, and with a Slight Chance of CH01 and/or CH02/- becoming geoeffective at the very end of the four days. Geomagnetic activity should be most reliably Quiet on day one, Monday 18 July, rising to a Chance of G1 on 19 and 20 July, fading to a Slight Chance on 21 July.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at Background levels, but with a daily Slight Chance of S1 or greater due to the presence of large sunspot regions in the west or near centre-disc.

The high energy electron flux (greater than 2 MeV) is expected to remain at High levels until Days 3 or 4 (19-20 July) when a CME is due to arrive and redistribute or suppress flux levels. Fluence levels above the Active (1e8 integrated pfu) threshold are likely to remain until the 15/1300UTC CME arrives whereupon a sharp fluence drop should occur.

Figure 1. Solar Analysis Valid 17/1745UTC.

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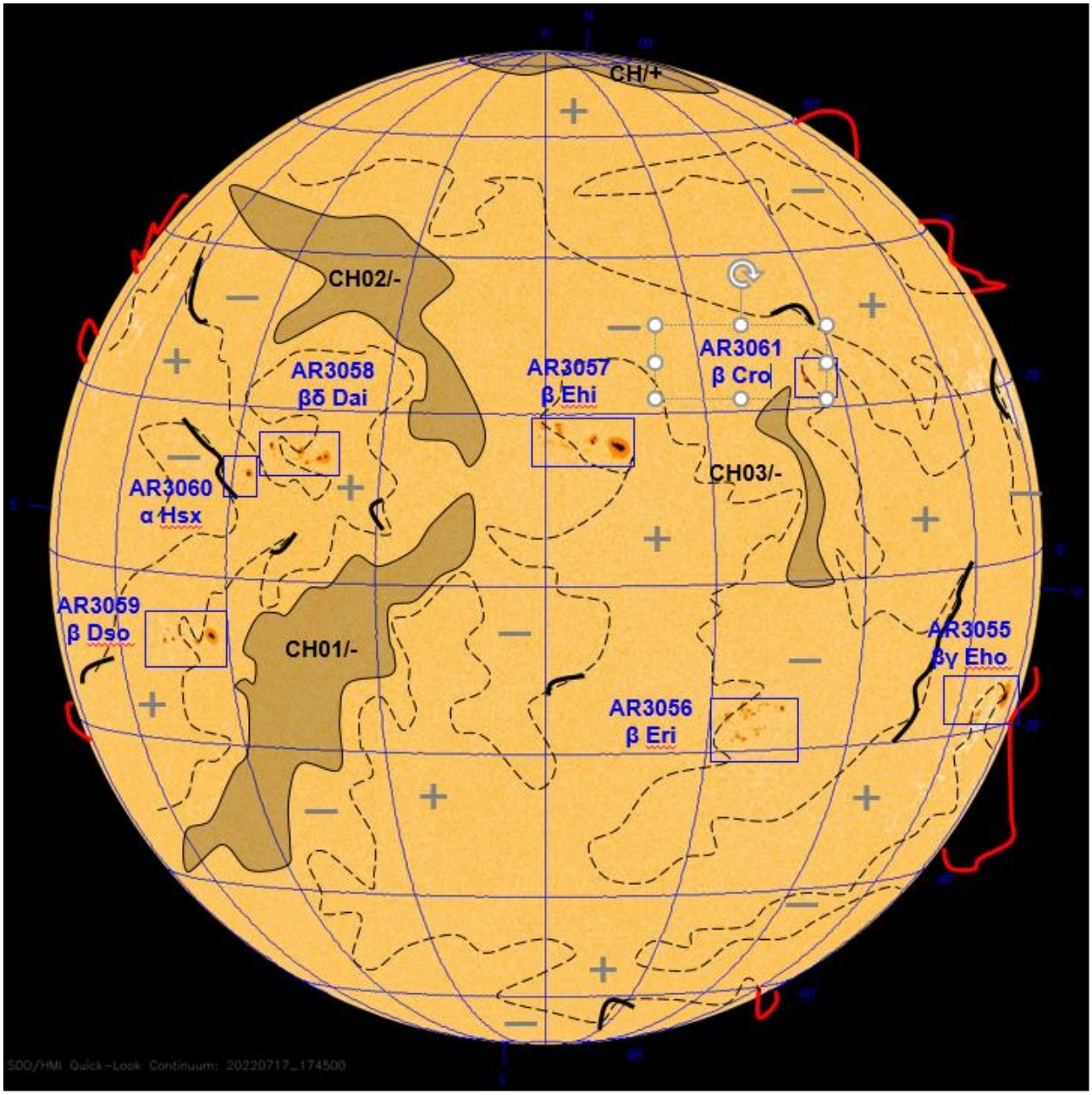
Met Office Space Weather Technical Forecast



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one confirmed CME in the forecast period: the 15/1300UTC filament CME, which is due around the turn of the UTC day 19 into 20 July. This feature ought to have some 'heft' for being spawned by a filament, and may well have a protracted transit time given the slow emission speed, giving a Chance of G1 on both 19 and 20 July, with a slight tail as late as 21 July.

The persistence forecast is expected to be less impactful, with CH03/- perhaps offering a token presence on 19 July in this expected transient-dominated period. There is then a Slight Chance of CH01 and/or CH02/- becoming geoeffective at the very end of the four days, should either be as fast as 600km/s, which is not out of the question given their visually-intensified appearance on AIA 211 versus last pass. This strengthens the tail of risk of G1 on day four, Thursday 21 July.
Geomagnetic activity should be most reliably Quiet on day one, Monday 18 July, rising to a Chance of G1 on 19 and 20 July, fading to a Slight Chance on 21 July.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	40	40	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0209	Partial	Filament eruption	NW quadrant	395 km/s	19/2359 UTC, +/- 9 hours	Partial halo with main ejecta ahead of Earth

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Figure 2: Latest MOSWOC Enlil run and ensemble, showing arrival of 15/1300UTC CME as most likely around the turn of the UTC day 19 into 20 July.

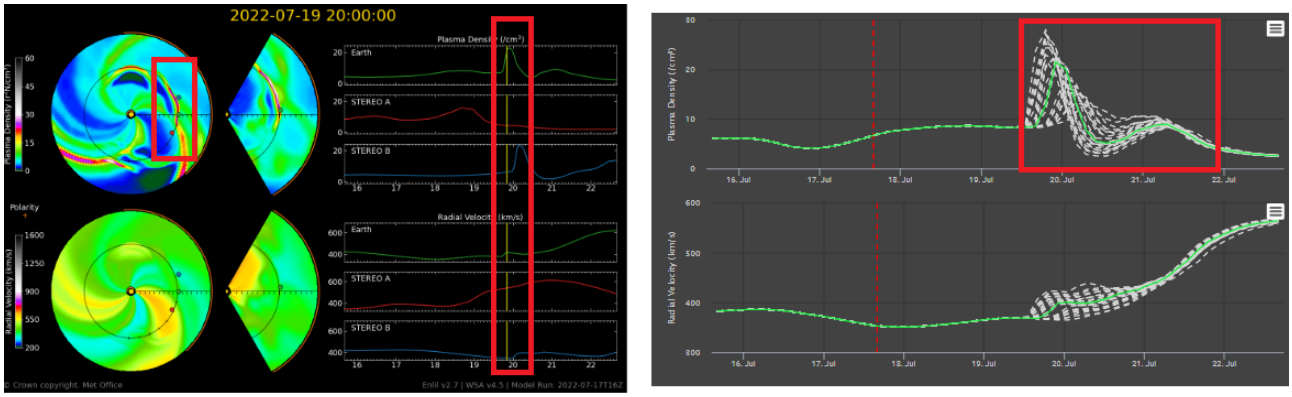
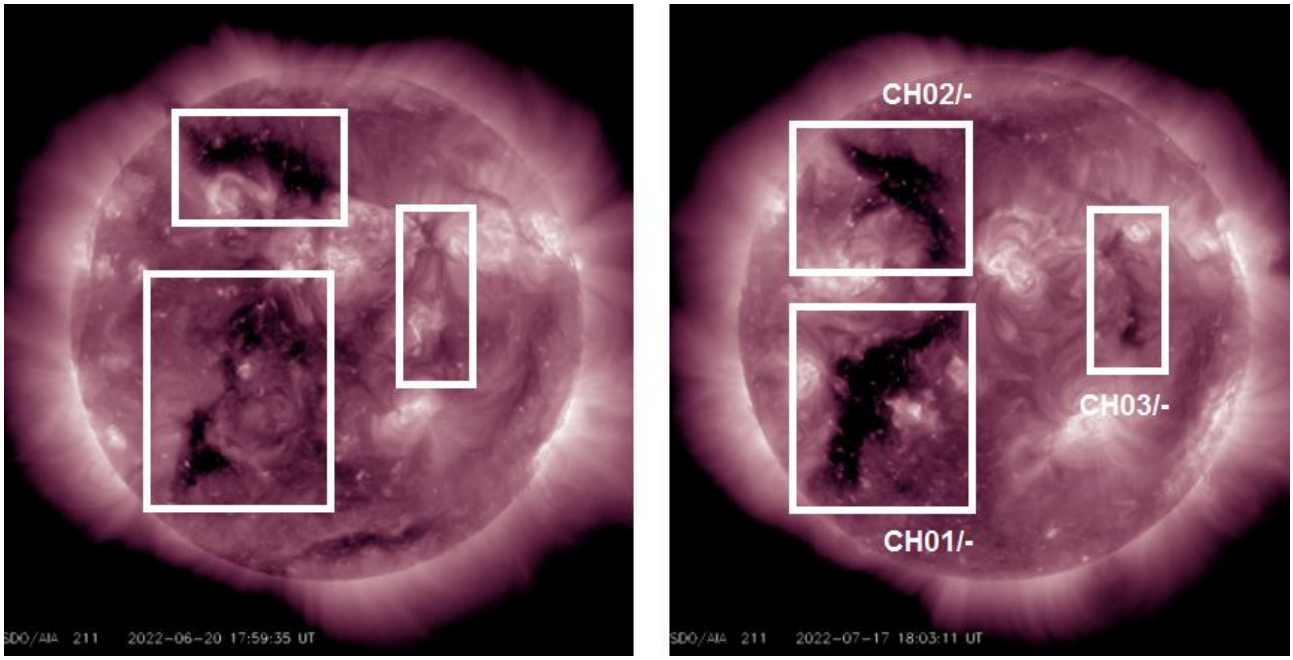


Figure 3: Coronal hole persistence for 20 June and 17 July, showing all three of the upcoming coronal holes and their analogues from last pass. CH01 and CH02 appear to have visually intensified in AIA 21 imagery, and may arrive at the end of the current four-day forecast - slightly ahead of a 27-day repeat period.



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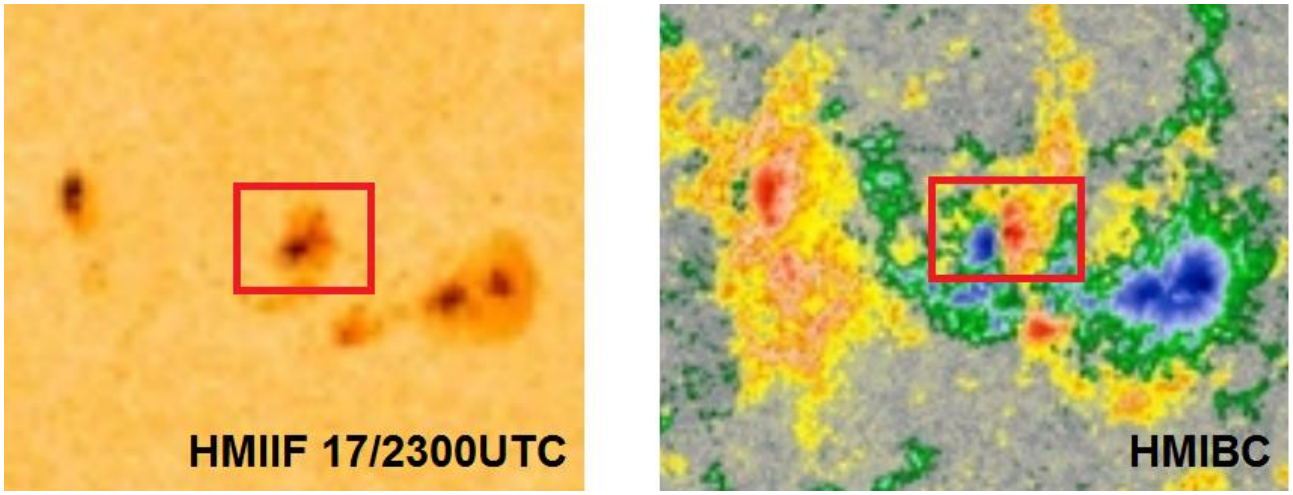
Radio Blackouts - X-Ray Flares:

Solar activity fell to Low in the UTC day of Sunday 17 July. Considering the overall balance of sunspot groups, two regions are due to leave the disc to start the current working week UTC, resulting in a gradual decline in the probability of flaring during the period. Arriving bright flux over the southeastern limb may compensate slightly for any loss, however this will be assessed as and when any region(s) arrive.

On paper, the most complex region is AR3058 (Dai/Beta-Delta) with its central Delta making it the most likely region to give M-class X-ray flares. However, there are a further four large regions with theoretically sufficient flux to also produce M-class activity, meaning the risk is fairly well-distributed across the visible disc, and changes should therefore be gradual.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	60	50	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: 17/2300UTC HMIIF and HMIBC imagery, showing sunspot region AR3058 with its Mt Wilson delta spot shown boxed in red.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at Background levels.

Owing to the complexity of the current disc, and in particular several large regions in the west or near centre-disc, there is a daily Slight Chance of S1 or greater occurring. This being said, none of the present front-side sunspots have any history of generating any flare-tied proton enhancements.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has changed character in the past 24 hours in rising to a new higher diurnal oscillation in the wake of the recent high speed stream from CH99/+. This was expected given persistence forecasting, and should last until any CME influence on 19 into 20 July.

MOSWOC REFM is showing a slightly damped trend versus current observations, and it will not react to the transient-dominated forecast period, although the roughly level trajectory until any CME onset is accepted. Active fluence is Expected until later on 19 July, perhaps persisting as late as 20 July before a sharp drop-off following any CME arrival. Fluence levels probably will not recover in the period, with any fast wind from CH01/02 at the very end of the four days probably taking longer than the 96 hours of this forecast period to manifest as recovering fluence, although an eventual late-week rise is expected to some degree.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	40	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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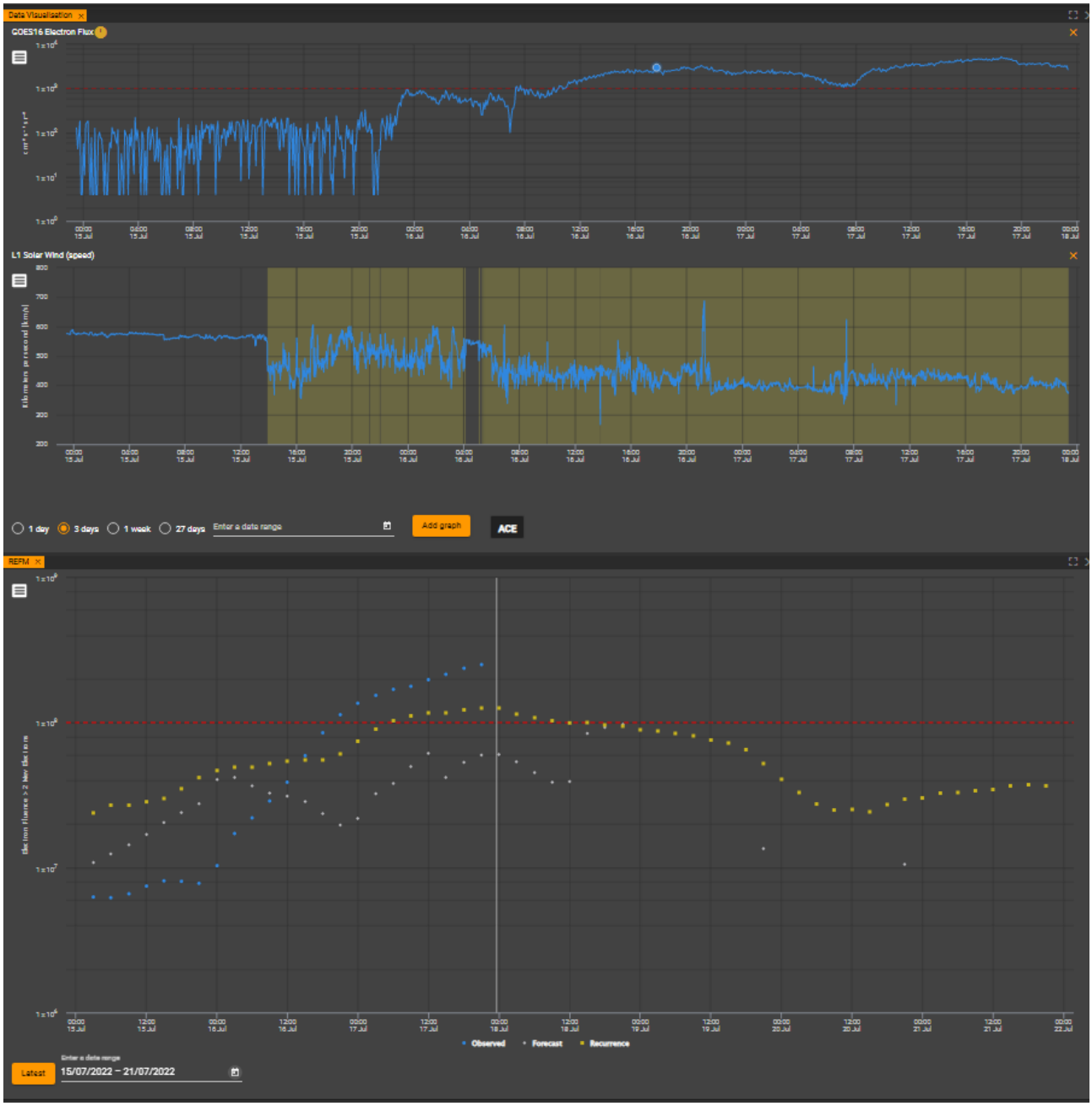
Figure 5: Past three days in GOES16 high energy electron flux and L1 solar wind speed, showing upward reaction to the recent near-600km/s fast wind from CH99/+. Also shown is the 24-hour fluence observations for the same period, as well as REFM's predictions for the subsequent 72 hours. While the trend is correct initially (relatively flat), the 15 July CME ought to result in a sharp downward trend in fluence from 19 or 20 July, not represented in the model.



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